

### 3. Be careful using long ground leads, especially near the transformer and switching elements

A long ground lead is convenient because the user can make one ground connection and probe many test points within the range of the ground lead. However, any piece of wire has distributed inductance, and the distributed inductance reacts to AC signals by increasingly impeding AC current flow as signal frequency increases. The ground lead's inductance interacts with the probe input capacitance to cause ringing at a certain frequency. The ring frequency is described by the following formula:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Where:

$V$  = the ring frequency

$L$  = the inductance caused by the probe's grounding solution

$C$  = the probe's input capacitance

Equation 3. Ring Frequency Calculation.

This ringing is unavoidable, and may be seen as a sinusoid of decaying amplitude. As the length of the ground lead increases, the inductance increases and the measured signal will ring at a lower frequency. The effects of ringing can be reduced by limiting the length of the probe's grounding or by choosing a probe with lower input capacitance.

One simple solution to improve the ring frequency is to use a shorter piece of grounding wire such as a short ground spring.

A picture of a probe with a short ground spring is shown on the left side of Figure 4. With a short ground spring, the inductance is reduced, decreasing the LC value and pushing the inductive ringing out past the frequency range of interest.



Figure 4. Chassis mount test jack.

A grounding solution with the least amount of inductance while obtaining a secure ground connection is a probe tip chassis mount test jack (Tektronix part number 131-4210-00) shown on the right side of Figure 4. The jack can be inserted into the user's test board and reduces the ground lead length to almost zero.

The grounding wire can also act as an antenna or a loop, causing capacitive and magnetic coupling effects. An added benefit of reducing the ground lead length is reduced exposure to radiated emissions near the transformer and switching devices. If a longer ground lead is required, the user should be careful not to place the grounding wire near a transformer or switching device.